Project name, IRN	**AP23488688** – Experimental study of fundamental mechanisms increasing the luminescence yield of ionic crystals at room temperature
Completion date	01.01.2024-31.12.2026
Project supervisor	Shunkeyev Kuanyshbek, d.ph.-m.s., professor
Report	Currently, ionic crystals (LiF, NaF) are widely used as optical materials, transparent in a wide spectral range, scintillation and thermoluminescent dosimeters for detecting ionizing radiation in the nuclear and atomic industry, medicine and ecology, etc. The uniqueness of ionic crystals lies in enabling simultaneous study of two processes: luminescence yield (scintillators) and the efficiency of radiation defect formation (dosimeters), originating from the decay of self-trapped excitons (STEs). Despite the prevalent use of STE-based scintillators, several drawbacks persist: firstly, reduction of initially high luminescence yield at low temperatures (η≈1); secondly, undesirably long afterglow; thirdly, material hygroscopicity and the need of storage in evacuated capsules. Universal scintillators meeting all criteria haven't been found yet, necessitating a study of the fundamental mechanisms that increase luminescence yield of ionic crystals at room temperatures. This project introduces a novel approach by focusing on the mechanism converting absorbed ionizing particle energy into light through by assembling electron-hole (e-h) pairs, the luminescence yield of which, unlike STE, increases with temperature. The research group has demonstrated significant progress in searching for fundamental mechanisms to increase luminescence yield of ionic crystals. Using KCl-Na as an example, intense luminescence of exciton-like formations (ELFs) was recorded for the first time globally, surpassing existing CsI and CsI-Na scintillators.
Relevance	These experimental results confirm the relevance of studying the fundamental mechanism for increasing light yield in scintillation detectors at room temperatures, associated with recombination assembly of exciton-like formations with impurity cations' involvement. Consequently, a systematic study of ELF's fundamental mechanisms in ionic crystals under conditions of reduced lattice symmetry is necessary. This approach addresses the fundamental physical problem of ELF creation and a promising applied problem, such as the development of chloride-based scintillation crystals relying on the recombination assembly of ELF during the relaxation of correlated electron-hole pairs.
Purpose	Using experimental methods, establish the fundamental mechanism of decay of electronic excitations (exciton-like formations, electron-hole pairs), leading to an increase in the luminescence yield of ionic crystals at room temperature.
Expected results	• Ionic crystals with various concentrations of cation impurities will be synthesized on the basis of crystal matrixes grown in evacuated ampoules or inert atmospheres. • The quality of synthesized samples will be analyzed by recording their absorption (optical absorption spectra), luminescence (XRL, TL, TL decay kinetics) and thermoactivation characteristics (TSL and TSL spectra). • By studying the XRL spectra of ionic crystals doped by

	• The luminescent and thermoactivation characteristics of doped ionic crystals exposed to thermoelastic and uniaxial deformation will be studied in order to stimulate the ELF assembly allowing to increase the luminescence yield at RT. • The absorption/thermoactivation characteristics and TL decay kinetics of doped ionic crystals will be studied in order to elucidate the mechanisms of radiation defect accumulation and to estimate the interdefect distances within tunneling pairs. • The obtained novel experimental data will be analyzed to determine the main mechanism of increasing the luminescence yield at RT.
Research group	Supervisor – Main researcher*:* Shunkeyev Kuanyshbek, d.ph.-m.s., professor, H index = 12 (Researcher ID O-8849-2017; ORCID 0000-0002-3860-397X; Scopus Author ID 57211063006).

	https://www.scopus.com/authid/detail.uri?authorId=57211063006 Lushchik Aleksandr, d.ph.-m.s., professor, H index=34 (Researcher ID F-9130-2013; ORCID 0000-0003-2035-3420; Scopus Author ID 7006987094) https://www.scopus.com/authid/detail.uri?authorId=7006987094 Sagimbaeva Shynar, c.ph.-m.s., associated professor, H index=7 (Researcher ID ABC-4687-2021; ORCID 0000-0002-1234-3030; Scopus Author ID 6602130267) https://www.scopus.com/authid/detail.uri?authorId=6602130267 Sergeyev Daulet, c.ph.-m.s., professor, H index=10 (Researcher ID O-3783-2017; ORCID 0000-0001-7426-3039; Scopus Author ID 55237792800). https://www.scopus.com/authid/detail.uri?authorId=55237792800 Myasnikova Lyudmila, c.ph.-m.s., associated professor, H index=7 (Researcher ID O-9697-2017; ORCID 0000-0003-3326-7206; Scopus Author ID 16481268100). https://www.scopus.com/authid/detail.uri?authorId=16481268100 Aimaganbetova Zukhra, PhD, associated professor, H index=7 (Researcher ID E-4496-2015; ORCID 0000-0002-8765-516X; Scopus Author ID 56305678700). https://www.scopus.com/authid/detail.uri?authorId=56305678700 Ubayev Zhiger, PhD, H index=5 (Researcher ID CDN-9919-2022; ORCID 0000-0002-8862-3506; Scopus Author ID 57211061571). https://www.scopus.com/authid/detail.uri?authorId=57211061571 Assel Istlyaup, master, H index =2 (Researcher ID GDL-1881-2022; ORCID 0000-0003-3423-5126; Scopus Author ID 57211115630). https://www.scopus.com/authid/detail.uri?authorId=57211115630 Duisenova Ainur, PhD, H index =2 (Researcher ID CNL-5127-2022: ORCID 0000-0003-4868-1944; Scopus Author ID 57221375049) https://www.scopus.com/authid/detail.uri?authorId=57221375049 Kenzhebayeva Adelya, PhD Student, H index =1 (Researcher ID DAI-0449-2022; ORCID 0000-0002-0214-9517; Scopus Author ID 57358022800) https://www.scopus.com/authid/detail.uri?authorId=59249718200
Publications in scientific publications	1. K. Shunkeyev, S. Sagimbayeva, Z. Ubaev, A. Kenzhebayeva. Mechanisms for Enhancing Luminescence Yield in KBr Crystals under the Influence of Low-Temperature Uniaxial Elastic Deformation // Crystals, 2024, Vol. 14, 698. DOI: https://doi.org/10.3390/cryst14080698 (Scopus – 60%, WoS – Q2). 2. K. Shunkeyev, A. Lushchik, S. Sagimbayeva, Z. Ubaev, A.

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